Uganda

Assessing the Costs of Distribution to Health Sub-Districts

A Case Study in Financial Analysis

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DELIVER

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Implemented by John Snow, Inc. (JSI), (contract no. HRN-C-00-00-00010-00), and subcontractors (Manoff Group, Program for Appropriate Technology in Health [PATH], Social Sectors Development Strategies, Inc., and Synaxis, Inc.), DELIVER strengthens the supply chains of health and family planning programs in developing countries to ensure the availability of critical health products for customers. DELIVER also provides technical support to USAID's central contraceptive procurement and management, and analysis of USAID's central commodity management information system (NEWVERN).

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Abstract

In December 2002, DELIVER conducted an assessment of distribution costs for the public supply chain for essential medicines in Uganda, requested by the USAID and the DELIVER resident advisor, after discussions with the National Medical Stores (NMS), the Danish International Development Agency (DANIDA), and the Ministry of Health. The decision makers knew that major changes in the Ugandan health system—decentralization and a change from a push to a pull system for commodities management—were going to significantly impact the resources and responsibilities for delivering medicines and supplies to the lowest levels of the supply chain. Managers and policy advisors from the NMS, DANIDA, USAID, and DELIVER agreed that a financial analysis would help them consider alternatives and make better choices about how to structure the distribution system in the future. This case study describes the analysis and details lessons learned for logistics management advisors and staff, based on the following questions:

1. Does the NMS have the excess capacity for vehicle operating days to make deliveries down to the health sub-districts (HSD) level?
2. What is the incremental cost if the NMS distributes to the HSDs, in addition to the costs they now incur to deliver to the District level? How does this cost compare to the costs being incurred under the existing system, where the Districts and HSDs share the cost of delivery from the District level down to the facilities in each HSD?
3. How can the incremental cost of NMS distribution to the HSDs be funded? Can the costs saved by the Districts and HSDs fund the incremental cost of NMS distribution? Will this cover the total incremental cost? Can the current financing, provided through client fees, cover the operating costs of NMS as currently configured (i.e., with distribution to the District level)?

This report explains the purpose of the study, how it was designed, what methods were used for data collection, and how the analysis was done. It then describes the findings of the assessment and how they were used to make decisions. The final section lists questions to elicit insights for financial logistics planning and management decision making.

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Acronyms

DANIDA	Danish International Development Agency
HSD	Health Sub-District
MOH	Ministry of Health
NMS	National Medical Stores
PHC	Primary Health Care
STI	sexually transmitted infections
UGX	Ugandan Shillings
USAID	U.S. Agency for International Development

Case Study in Financial Analysis

In December 2002, the DELIVER project conducted an assessment of distribution costs for the public supply chain for essential medicines in Uganda (Abdallah, Healy, and O'Hearn 2002). The analysis was requested by the U.S. Agency for International Development (USAID) and the DELIVER resident advisor, based on discussions with staff from the National Medical Stores (NMS), the Danish International Development Agency (DANIDA), and the Ministry of Health (MOH). It was clear to everyone that major changes were taking place in the Ugandan health system, including decentralization and a change from a *push* to a *pull* system[1] for commodities management. These changes were going to have a significant impact on resources and responsibilities for delivering medicines and supplies. Managers and policy advisors from the NMS, DANIDA, USAID, and DELIVER felt that financial analysis would help them consider alternatives and make better choices about how the distribution system should be structured in the future.

This case study explores the analysis conducted in Uganda, drawing out lessons learned for logistics management advisors and staff. The study summarizes the purpose of the study, how it was designed, what methods were used for data collection, and how the analysis was done. The study then describes the findings of the assessment and how they were used for decision making. In the final section, the reader will find information that will help with financial logistics planning and management decision making.

1. Background

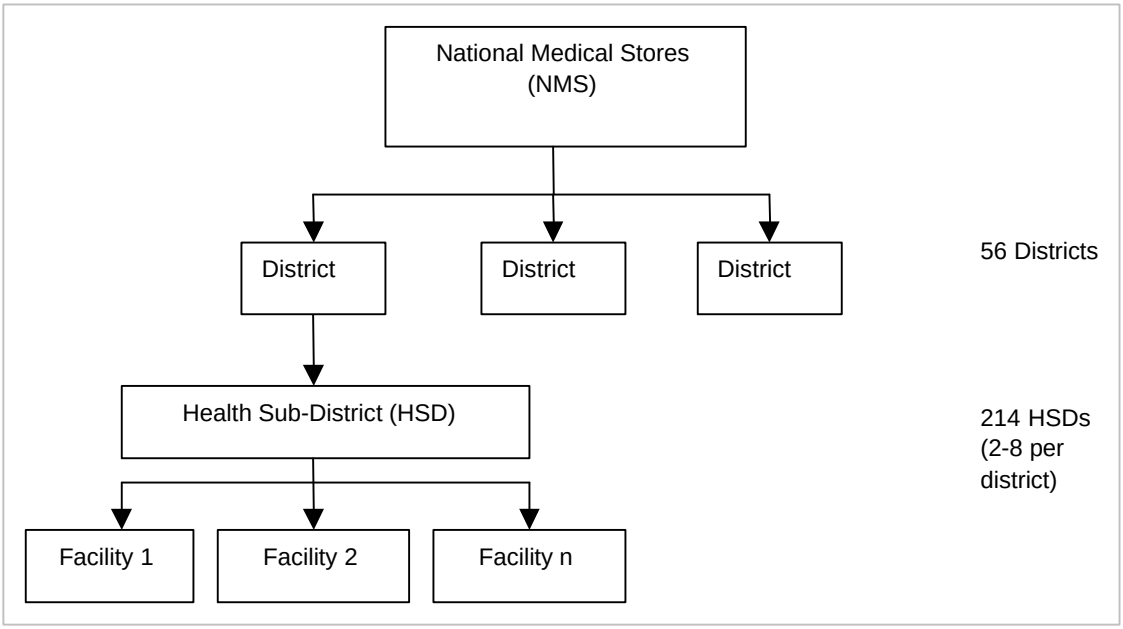
Current Situation

Figure 1 shows the structure of the distribution system for public sector medicines and supplies in Uganda at the time of the study. Within this system, the NMS distributed pre-packaged kits of essential medicines and other medical supplies to District Health Offices, where the supplies were then redistributed to Health Sub-District Offices (HSDs) or, in some cases, directly to health centers. Each of the 56 districts in Uganda can have 2–8 HSDs, covering approximately 8–10 health centers each.

The drug kits system had been in place since 1997, supported by DANIDA and the Uganda Essential Drugs Programme. In addition to the *push* system of supply for the drug kits, some medicines (mostly emergency orders) were purchased directly by the HSDs using a special budget allocation called Primary Health Care (PHC) funds. NMS delivered medicines and supplies to districts and district hospitals quarterly. Districts then delivered to the HSD office or individual facilities within the HSDs, or staff from the HSDs would pick up from the Districts and deliver to the facilities.

[1] In *push* systems, a higher-level facility decides what commodities move down the system and when they move down. In *pull* systems, the lower-level facility orders commodities as the need arises.

Figure 1.
Distribution System for Public Sector Medicines and Supplies in 2002



Problems associated with this delivery system included the unpredictable delivery schedule, unreliable modes of transportation at the district level, shortages of fuel, and poor communication between the District and the HSDs. First, because the Districts and HSDs didn't know when the NMS was going to arrive with a shipment, they couldn't reserve a vehicle in advance or plan for distribution down to the facility level. The HSDs do not have storage facilities, security, or staff trained in stores management, so they needed to carry orders directly to the facilities. The HSD often was not aware that the District had received the order, and sometimes discovered it only by chance. In addition, District level storekeepers and auditors didn't know when they would be needed to inspect and accept a delivery, causing more delays as the NMS staff waited for them at the District level.

The distribution system was financed in two ways:

1. The programs ordering and donating the medicines and supplies (usually the MOH, DANIDA, or USAID) were charged a handling fee by the NMS. This fee included distribution to the District level. For example, DANIDA paid a fee of 10 percent of the product value for the essential drug kits ordered and delivered. Districts and HSDs then used their own resources to pay for the distribution cost from the District to the facility level.

2. They sometimes used money from the PHC Fund allotted for transport activities, although the release of those funds was unpredictable and inconsistent. The District usually supplied a pick-up truck, while the HSD paid for the per diem of the driver and the fuel. About half the time, the HSD was able to combine trips (i.e., pick up drugs while doing supervision or something else), thus saving distribution expenses.

Anticipated Changes

By the end of 2002, it was clear that decentralization was moving forward in Uganda. One of the functions being decentralized to the HSD level was responsibility for budgeting and ordering their drug and medical supply needs using PHC funds. Another important development affecting

the supply chain was that, as of December 2002, the donated drug kit system was ending and a *pull system* for drug distribution was slated to begin.

Under the pull system for the donated medicines, the HSDs would select the types and quantities of essential medicines and supplies to order and receive, with autonomy for budgeting and placing the order. They would base their orders on requests filled out by facilities, and the district would approve the order. The HSD would then place the order and would receive commodities from the NMS. The pull system envisioned bimonthly rather than quarterly deliveries.

The anticipated changes left several questions in the minds of staff from NMS, DANIDA, and DELIVER. Would it be more cost-effective for the NMS to deliver down to the HSD level? How should distribution be organized and financed under the new system? There was a feeling that having NMS responsible for delivery might improve the reliability of the system, because the communication between the Districts and the HSDs would no longer be a problem. But, it was not clear whether the NMS had the capacity to undertake these additional tasks or how much the new arrangement would cost. These questions drove the need for an assessment of the costs of distribution to the HSD level in Uganda.

Section 2 describes how the scope, objectives, and analytical approach of the cost analysis were defined, how the study was set up, and how the clients and technical consultants decided what was to be measured.

2. Designing the Analysis

Purpose and Objectives

Three technical consultants were engaged to conduct the analysis over a three-week period. The purpose of the study was to determine the feasibility of having the NMS take on the additional responsibility of delivering medicines and supply orders down to the HSD level.[2] The scope of work included the following questions:

1. Can the NMS deliver to the HSDs? In other words, does the NMS have the necessary excess capacity in terms of vehicle operating days to assume responsibility for deliveries down to the HSD level?

2. What is the incremental cost of the NMS distributing to the HSDs, over and above the costs they are now incurring to deliver to the District level? How does this cost compare with the costs now being incurred under the existing system, where the Districts and HSDs share the cost of delivery from the District level down to the facilities within each HSD?

3. How can the incremental cost of NMS distribution to the HSDs be funded? Can the costs saved by the Districts and HSDs be used to fund the incremental cost of NMS distribution? Will this cover the total incremental cost?

4. Is the current financing provided through client fees adequate to cover the operating costs of NMS as it is now configured (i.e., with distribution to the District level)?

[2] The study also looked at the potential for outsourcing transport and distribution functions and identifying local carriers that might be interested in this business. See the original cost study for the findings related to this objective (Abdallah, Healy, and O'Hearn 2002). This case study does not discuss the issues around outsourcing.

Scope and Approach

The decisions being considered would affect the structure and organization of the national distribution system for public sector health commodities; therefore, the analysis needed to be generalizable at the national level. To provide the most accurate estimates, the study team collected data that covered either a full year of operation or a complete delivery cycle, as appropriate. The study used fiscal year 2001 data for estimates.

While quantitative data was very important for answering the study questions, the study organizers also saw the value of collecting qualitative data, including perceptions of stakeholders regarding the feasibility of options. Qualitative interviews also helped determine assumptions needed for the cost analysis, i.e., which costs were relevant to the decisions being made, how the costs behave in relation to changes in volume of services provided or kilometers traveled, and how much control staff had over the costs incurred in the distribution process. Finally, the scope of the study extended to *what-if* scenarios, where the projected impacts of several alternative decisions were analyzed and compared.

Several approaches were used to assemble the information needed to answer the study questions. These are grouped below into three categories.

- *Analysis of capacity.* To determine whether the NMS had the capacity to take on the additional responsibilities for distribution to HSDs, the study needed to conduct an analysis of capacity. The study would determine the number of vehicle operating days available (given NMS's current fleet and mode of operation), and compare this to the number of vehicle operating days that would be needed if the NMS were to assume the new delivery responsibilities. Interviews with stakeholders helped validate assumptions used in the calculations.

- *Incremental cost analysis.* The type of cost analysis required depends on the decision being made. The decision of whether to add a new delivery service to NMS's responsibilities is one that requires incremental cost analysis (also called differential analysis). In other words, how will costs change or be different if the NMS adds the new delivery service to the activities it is already doing? An incremental cost analysis may look at fixed, variable, direct, or indirect costs, but only considers those costs that will be different under the new scenario.

- *Cost recovery analysis.* Whether current fees or prices paid by clients are adequate to cover NMS operating costs is a question that requires full cost information. The full cost of distribution and storage services that a given client has incurred needs to be determined, then compare those costs to the actual revenue paid by the client.

  Cost recovery analysis requires costs to be allocated to the different clients or users of the NMS transport and storage department services (e.g., donors, the MOH, and the NMS commercial sales division). Each client is allocated a fair portion of the total operating costs, according to actual use. Two statistics were used to allocate costs in this study: product value and product volume. While product value is easily traced through the computerized management information system used by the NMS (a commercial product called Navision), in reality, operating costs are driven more by product volume, information that is not easily available clients in the current system. The study needed to analyze pack sizes and create volume indicators so operating costs could be allocated fairly to clients, based on product volume.

Defining What to Measure

Table 1 shows the information needed for each type of analysis and the indicators measured. Section 3 of this case study discusses, in more detail, how data were collected, while section 4 describes the calculations used to create the indicators.

Table 1. Information Needed and Indicators Measured, by Type of Analysis

Type of Analysis	Information Needed	Indicator Measured
A. Capacity Analysis	Maximum capacity of the NMS	A1. Available vehicle operating days
	Capacity already being used for delivery (current requirements)	A2. Kilometers traveled for delivery to Districts
		A3. Vehicle operating days used for delivery to Districts
	Capacity needs when HSD locations are added to the delivery schedule	A4. Required kilometers NMS-District-HSD
		A5. Required vehicle operating days NMS-District-HSD
B. Incremental Cost Analysis	Existing costs of distribution incurred by Districts and HSDs for delivery to the facility level	B1. Reported current District-HSD delivery costs
		B2. Estimated current District-HSD delivery costs
		B3. Probable current District-HSD delivery costs
	Direct cost per unit (fixed and variable) of distribution incurred by the NMS to deliver to the District level	B4. Average NMS running cost per kilometer
		B5. Average NMS standing cost per vehicle operating day
	Cost of adding distribution to HSD level to the NMS schedule	B6. Incremental kilometers to deliver to HSD
		B7. Incremental vehicle operating days to deliver to HSD
		B8. Incremental NMS District-HSD delivery costs
C. Cost Recovery Analysis	Full cost (direct and indirect) of NMS operations	C1. Total NMS operating cost
	Allocation statistics (volume and product value) for allocating operating costs to clients	C2. Average volume per pack size group
		C3. Total volume per product group
		C4. Total product volume per client
		C5. Total product value per client
	Percentage of operating costs covered by client fees	C6. Operating cost by client, allocated by product value
		C7. Operating cost by client, allocated by volume
		C8. Total revenue by client
		C9. Percentage of operating costs (allocated by volume) recovered by client revenue
		C10. Required percentage of product value needed to cover share of operating costs (allocated by volume)

3. Collecting Data

The study team started by interviewing key stakeholders and conducting field visits to eight districts, a sample limited by the time period available for the study. The selection of sites was non-random, and was designed to provide a representative sample of districts and HSDs. NMS staff helped select the sites, based on their field experience. Criteria included—

- Districts located nearer to and farther from the NMS in Entebbe.
- Districts that were large and dense and Districts that were smaller and more sparsely populated.
- Districts with different types of geography, i.e., mountainous versus more level terrain.
- Districts that reflected a variety of existing distribution practices.

The interviews with district and HSD staff provided estimates of reported costs for district to HSD delivery, as well as the percentage of deliveries that were shared. During the field visits, the study team created district maps and marked the routes and distances to all HSDs within the sample. They also collected unit cost information and assumptions, such as fuel consumption rates, average vehicle speeds, and policies and rates for allowances for drivers. Cost data collected from the sample districts were extrapolated to the national level using the mean distribution cost per capita from the sample districts.

To complement the field visits and key informant interviews, the study team conducted a survey of 150 health managers involved in the implementation of delivery systems. This was timed to coincide with a series of regional workshops on the transition from a push to pull system for the supply of donated essential medicines.

For NMS costs, the study team analyzed reports and records from the NMS Navision automated medical stores management system. These records included the profit and loss accounts for fiscal year 2001 and client invoices. Records from the NMS transport section provided data on the days each vehicle was used for distribution compared to the total vehicle operating days and the kilometers traveled by each vehicle per month.

Finally, for analysis of product volume, the study team took a random sample of product packs to determine average pack volume, then applied these estimates to actual product pack delivery information obtained from client invoice records. Section 4 describes the capacity, cost, and volume analyses in more detail.

4. Analyzing and Interpreting Data

As described in section 2, the study had four objectives or key questions. These questions were answered through three types of analysis: (a) Capacity Analysis, (b) Incremental Cost Analysis, and (c) Cost Recovery Analysis. This section describes how the analyses were done and how they helped answer the key questions.

A. Capacity Analysis

Question 1: Can the NMS deliver to the HSDs? In other words, does the NMS have the necessary excess capacity in terms of vehicle operating days to assume responsibility for deliveries down to the HSD level?

To answer question 1, the study team needed to determine the maximum capacity of the NMS in terms of vehicle operating days available for delivery. Then, the study team needed to find out how much of this available capacity was already being used to deliver to the Districts. Finally, the study needed to calculate how many more vehicle operating days would be needed to deliver to the HSDs, and whether this additional work could be accomplished within the total available

vehicle operating days. Table 2 shows the indicators that were measured to obtain this information, giving more detail on how the calculations were done. For further details, see the original cost study (Abdallah, Healy, and O'Hearn 2002).

Table 2. Capacity Analysis: Information, Indicators, and Calculations

Information	Indicator Measured	Calculation
Maximum capacity of the NMS	A1. Available vehicle operating days	Number of vehicles times the number of operating days per year.
Capacity already being used for delivery (current requirements)	A2. Kilometers traveled for delivery to Districts	Total kilometers per year used for distribution functions, calculated by adding kilometers for all delivery routes, times six bimonthly deliveries per year.[3]
	A3. Vehicle operating days used for delivery to Districts	Total operating vehicle days per year used for distribution functions, calculated by dividing kilometers traveled for delivery to districts (measure A2) by average speed traveled per hour; then convert this to days (assuming an 8-hour workday). Added to this number the average days used for loading and unloading at pick up and each delivery point, based on estimates from NMS staff.
Capacity needs when HSD locations are added to the delivery schedule	A4. Required kilometers NMS-District-HSD	Total kilometers traveled to deliver to Districts plus HSDs, including required road time, loading and unloading time (extrapolated to all Districts based on sample of 8 Districts).
	A5. Required vehicle operating days for NMS-District-HSD	Vehicle operating days needed to deliver to Districts plus HSDs, including required road time, loading and unloading time (extrapolated to all Districts based on sample of 8 Districts).

Measure A1

The total *Available vehicle operating days* (measure A1) was calculated by multiplying the number of NMS vehicles available by the total number of operating days in the year. The number of operating days is the total number of working days in the year (52 weeks × 5 days/week = 260), minus holidays (eight/year) and scheduled maintenance days (24/year), or 228 available operating days per vehicle, per year. Thus, the total available vehicle operating days in this setting was four vehicles × 228 days or 912 days.

[3] The planned move from quarterly to bimonthly deliveries means that two deliveries to the District level are incremental (in addition to the current schedule); however, the study team included them in the baseline to simplify the analysis. This assumption means that capacity already being used may be overestimated (measures A2 and A3).

Measures A2 and A3

How much of the available capacity was already being used to deliver to the Districts? This question required the study team to analyze the existing delivery routes for delivery. The study team then calculated two indicators: *Kilometers traveled for delivery to Districts* (measure A2), and *Vehicle operating days used for delivery to Districts* (measure A3). To determine an annual total, the team multiplied the kilometers needed for the existing delivery route by six, for bimonthly delivery. Kilometers were then converted into vehicle operating days by dividing by the average speed per hour, then converting hours to days (assuming an eight-hour workday). In addition to vehicle operating days used for travel, the study team gathered estimates for the time needed to load and unload the trucks. NMS estimates for unloading time were somewhat high because they included time spent waiting for appropriate audit personnel to arrive and audit each shipment.

The calculations revealed that 522 days were already being used to deliver to the Districts or about 57 percent of the 912 total available vehicle operating days (see table 3). The analysis showed that the NMS did have some excess capacity that could be used to deliver to the HSDs. The next question was whether this excess capacity was sufficient, given how many vehicle operating days would be needed to deliver down to the HSD level.

Measure A4 and A5

Two indicators were measured to estimate capacity needs when HSD locations are added to the delivery schedule: *Required kilometers for delivery from NMS to Districts and to HSDs* (measure A4), and *Required vehicle operating days for delivery from NMS to Districts and to HSDs* (measure A5). The team already knew the kilometers and operating days needed for delivery to the Districts, so the missing piece was the additional (incremental) kilometers and days needed to deliver to the HSD level. This information was determined for the eight sample districts by mapping actual transport routes and the number of kilometers traveled to get to and from each HSD, multiplying by six (for bimonthly delivery), dividing by the average speed per hour, then converting hours to days, as described earlier. Loading and unloading times were also included.

An additional step required the study team to estimate the kilometers and vehicle operating days for the national delivery schedule to all Districts using the data from the sample Districts. This was done by calculating the mean vehicle operating days required per person for the sample districts, then multiplying this rate by the national population.[4] The team found that 1,088 vehicle operating days would be required for delivery from NMS to Districts and to HSDs (measure A5). The final step in analysis of capacity was to compare this total with the available capacity (measure A1). This comparison (table 3) showed that the number of days required to deliver to the Districts and HSDs would exceed the existing capacity of the NMS by 19 percent.

[4] The study team used population means from the sample districts to extrapolate both national capacity estimates (vehicle operating days) and cost data.

Table 3. Capacity Analysis—Results

NMS Capacity	Vehicle Operating Days	Percentage of Maximum Available Capacity (%)	Unused (over-used) Capacity, Compared to Maximum (%)
Maximum available	912	100	0
Capacity for delivery to Districts 6 x year	522	57	43
Capacity when adding delivery to HSDs)	1,088	119	(19)

B. Incremental Cost Analysis

Question 2: What is the incremental cost of the NMS distributing to the HSDs, over and above the costs they are now incurring to deliver to the District level? How does this cost compare to the costs now being incurred under the existing system where the Districts and HSDs share the cost of delivery from the District level down to the facilities within each HSD?

Question 3: How can the incremental cost of NMS distribution to the HSDs be funded? Can the costs saved by the Districts and HSDs be used to fund the incremental cost of NMS distribution? Will this cover the total incremental cost?

Questions 2 and 3 required *incremental cost analysis,* examining both existing costs and how those costs may be different if the distribution system is changed to include delivery to the HSD level. First, the study team needed to determine the existing costs of distribution incurred by the Districts and HSDs for delivery from the District to the facility level. Then the study team needed to determine the existing direct costs (fixed and variable) of distribution incurred by the NMS to deliver to the District level.[5] Finally, the study needed to determine the incremental cost of adding the new responsibility for the NMS to deliver medicines and supplies down to the HSD level. Table 4 displays how the calculations were done for each indicator. Additional details are found in the original study.

[5] The study team concluded that indirect costs (for example, office space and office overhead expenses) should not be included in the differential analysis because these establishment costs would not change if the vehicles covered more kilometers, or even if one or two more vehicles needed to be hired.

Table 4. Cost Analysis—Information, Indicators, and Calculations

Information	Indicator Measured	Calculation
Existing costs of distribution incurred by the Districts and HSDs for delivery to the facility level	B1. Reported District-HSD delivery costs	Asked Districts and HSDs to estimate cost for fuel and allowances paid during delivery to each HSD, once per cycle (no records were available at HSD level), and data cross-checked between HSDs. Sample data are extrapolated for an estimate of national costs (see explanation under measures A4 and A5.).
	B2. Estimated District-HSD delivery costs	Calculated kilometers needed to deliver to sample HSDs based on maps of routes, then divided by average speed per hour, then converted to days (assuming 8-hour work day). Added time needed for unloading at each delivery point, based on district staff estimates. Added fuel cost based on actual travel distance divided by average kilometers traveled per liter of fuel, times fuel cost per liter (estimates from sample districts). Added allowances based on days and nights traveled, times per diem rates (estimates from sample districts). Sample data extrapolated to national level.
	B3. Probable District-HSD delivery costs (minus shared costs)	Estimated costs are adjusted down to account for shared costs, where distribution is combined with another activity that would have happened anyway. Sample data extrapolated to national level.
Direct cost per unit (fixed and variable) of distribution incurred by the NMS to deliver to the District level	B4. Average NMS running cost per kilometer	Fuel and lubricants, maintenance and repairs, driver allowances, other running costs, divided by the total (actual) NMS operating vehicle kilometers traveled for any purpose.
	B5. Average NMS standing cost per vehicle operating day	Capital costs of vehicles (including depreciation and lease costs), taxes, insurance, driver salary, and benefits, divided by the total (actual) NMS operating vehicle days on the road, for any purpose.
Cost of adding distribution to HSD-level to the NMS schedule	B6. Incremental kilometers to deliver District-HSD, per delivery cycle	Based on maps of actual distances from District to all HSDs in 8 districts (including return trips). Sample data extrapolated to national level.
	B7. Incremental vehicle operating days to deliver District-HSD, per delivery cycle	Calculated for 8 districts in sample, using assumptions regarding road type (tarmac versus murram), average speeds per road type, 8-hour work day, and time spent unloading per site. Sample data extrapolated to national level.
	B8. Incremental NMS District-HSD delivery cost, per delivery cycle	(Incremental kilometers [measure B6] times average fuel and maintenance cost per km [data from financial accounts and travel logs, B4]) plus (Incremental vehicle operating days [measure B7] times average standing cost per vehicle operating day [measure B5 for existing vehicle, or adjusted for depreciation where existing capacity is exceeded and new vehicle is needed]) plus (Incremental vehicle operating days [measure B7] times day and overnight allowances for drivers [according to NMS policies]).

Measures B1, B2, and B3

Costs for distribution from the Districts to the HSDs were hard to estimate because District and HSD records did not specifically track these expenditures. In a situation like this, where data are lacking, it sometimes helps to use different approaches for estimating costs, to allow decision makers to compare the different estimates and use the one that seems most reasonable. The team in Uganda tried three methods to get a reasonable estimate of the order of magnitude of District to HSD distribution costs in the eight sample Districts. As shown in table 4, these include *Reported costs* (measure B1), gathered through interviews with local staff, who reported what they thought they were spending; *Estimated costs* (measure B2), gathered by the study team using the maps of distances and assumptions about vehicle speed, cost of fuel, and fuel efficiency; and *Probable costs* (measure B3), which adjusted estimated costs down according to the reported percentage of trips that were shared with other activities that would have happened anyway, thereby saving distribution costs. Sample data were inflated for a national estimate using a population-based inflator, as described earlier (see explanation of measures A4 and A5).

When the study team compared these estimates, they noted that reported costs were almost three times higher than estimated costs (see table 5). In addition, the percentage of shared costs (probable costs) was high, around 50 percent. The difference between the reported costs and the probable costs was more than 5 to 1 (18.2 million UGX, versus 3.3 million UGX).

Table 5. Incremental Cost Analysis of Distribution from Districts to HSD Level, per Delivery Cycle: Results (Millions of UGX)

Costs Incurred by…	Districts			NMS
Measure	Reported (measure B1)	Estimated (measure B2)	Probable (measure B3)	Estimated (measure B8)
Running Costs	18.2	6.5	3.3	18.8
Standing Costs	—	—	—	14.3
Total Costs	18.2	6.5	3.3	33.1
Ratio of Total Costs to Total Districts' Probable Costs	5.5	2.0	1.0	10.0

Measures B4 and B5

Direct costs for distribution include two components: *running costs* and *standing costs*. Running costs are variable costs related to distribution, including fuel and lubricants; maintenance and repair; and driver allowances, such as per diem. Standing costs include costs that are directly related to distribution, but are fixed and do not vary by the number of kilometers traveled. Standing costs include, for example, vehicle capital costs (depreciation), taxes and licenses required to operate vehicles, driver salaries, and benefits. The study team confirmed with the NMS staff that the grouping of standing and running costs described earlier was appropriate for their organization. Combined with data from the Transport Unit on total distances covered by NMS distribution vehicles and total days vehicles were on the road, data from Navision were used to calculate *Average running cost per kilometer* (measure B4) and *Average standing cost per vehicle operating day* (measure B5).

Measures B6, B7, and B8

Finally, measures B6–B8 capture the cost of adding HSD-level distribution to the NMS delivery schedule, i.e., the incremental cost of NMS delivery to the HSDs. The *Incremental kilometers to deliver District-HSD* (measure B6) and *Incremental vehicle operating days to deliver District-HSD* (measure B7) were calculated in the same way as the *Estimated costs for delivery by the districts* (measure B2), using only assumptions specific to the vehicles and operating policies of the NMS. For example, NMS vehicles can drive at higher speeds on tarmac, and drivers receive different day and overnight allowances. Estimates were then extrapolated to the national level, as calculated for measures A4 and A5. The *Incremental NMS District-HSD delivery cost* (measure B8) was then calculated by multiplying the units needed (operating vehicle days and kilometers) by the respective unit costs (standing cost per day and running cost per unit), as described in table 4.[6]

The cost analysis allowed the study team to answer question 2, as shown in table 5 (Abdallah, Healy, and O'Hearn 2002).[7]

The incremental cost of NMS distributing to the HSDs, over and above the costs they are now incurring to deliver to the District level, is 33.1 million UGX per delivery cycle. This is 10 times higher than the probable costs now being incurred by the Districts and HSDs. Even using the greatest estimate of District costs (reported costs), the incremental cost for NMS to assume these delivery responsibilities is 82 percent higher (33.1–18.2/18.2).

For question 3—How can the incremental cost of NMS distribution to the HSDs be funded?—the study team considered whether the costs saved by the Districts and HSDs could be used to fund the incremental cost of NMS distribution. Table 5 makes it clear that while the cost savings (3.3 to 18.2 million per delivery cycle, depending on the cost measure) can contribute to the costs of NMS distribution, the cost savings alone will be insufficient to cover the total incremental cost.

The study team used qualitative data to answer this question, also. Districts are now more efficient than NMS (deliver for less cost) and if districts had to pay for NMS delivery using PHC funds, fewer PHC funds would be available for other services now being financed through this source. Also, problems with delays in release of PHC funds would make this strategy operationally impractical. See section 5 for additional discussion of study findings and management decision making.

C. Cost Recovery and Volume Analysis

Question 4: Is the current financing for distribution provided through fees paid by clients adequate to cover the costs of NMS distribution as it is now configured (i.e., to the District level)?

Table 6 displays the kinds of information that were needed to answer this question, the indicators measured, and how each indicator was calculated. Several indicators for this analysis were available through routine information systems (for example, measure C1, *Total NMS operating cost*; measure C5, *Total product value*; and measure C8**,** *Total revenue per client*). Other indicators needed to be calculated, as explained after table 6.

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6 As standing costs are more or less fixed within a relative range of vehicle operating days, this method of calculating national costs can overestimate costs, especially if there is a lot of excess capacity. However, in this case, the study team did further analysis to estimate how the fixed costs would change under the national scenario, and found results that were similar to the results obtained from measure B8.

7 Results are presented per delivery cycle. Total annual costs can be calculated by multiplying costs per delivery cycle by four (current quarterly delivery schedule) or by 6 (proposed bimonthly delivery schedule).

Table 6. Cost Recovery Analysis—Information, Indicators, and Calculations

Information	Indicator Measured	Calculation
Total annual operating costs for NMS (direct and indirect)	C1. Total NMS operating cost	Operating costs are derived from Navision profit and loss reports, and include direct and indirect expenses.
Allocation statistics (volume and product value) for allocating operating costs to clients	C2. Average volume per pack size group	Volume was measured for a random sample of 10+ packs per pack size group (small, medium, and large). Calculated the average of the sample estimates for each pack size group.
	C3. Total volume per product	Average volume per pack size group (measure C2) x times number of packs of that size for a given product, added over pack size groups used for the product.
	C4. Product volume per client	Summarized the total volume for the product (measure C3) according to the client who received that product.
	C5. Total product value received by NMS, and product value by client	Obtained from client invoice records kept in Navision information system.
Percentage of operating costs covered by client fees	C6. Operating cost by client, allocated by product value	For each client: product value per client/total product, value received by NMS (measure C5) times total operating cost (measure C1).
	C7. Operating cost by client, allocated by volume	For each client: product volume per client/total product volume received by NMS (measure C4) times total operating cost (measure C1).
	C8. Total revenue per client	Totaled from records of client invoices in Navision information system.
	C9. Percentage of operating costs (allocated by volume) recovered by client revenue	For each client: client revenue (measure C8)/ operating cost for client, allocated by product volume (measure C7).
	C10. Required percentage of product value needed to cover share of operating costs (allocated by volume)	For each client: operating cost for client, allocated by volume (measure C7)/product value by client (measure C5).

Measures C2, C3, and C4

First, the study team needed to determine product volume for different clients or users, namely the MOH (two major groups of users), donors, and the NMS's internal clients handling its commercial sales.[8] This information was needed so that a fair portion of operating costs could be assigned to each client, based on volume. Because product pack volume is not tracked by client name in the Navision computerized system, the volume per pack size group was estimated based on sample data. Packs were categorized into three size groups: small (< .040 m^3), medium (.040–.060 m^3), and large (> .060 m^3). Volume was measured for a random sample of 38 packs (about ten packs per pack size group), to get an estimate of *Average volume per pack size group* (measure C2). For each product, the study team then calculated *Total volume per product* (measure C3) by multiplying the number of pack shipments of products to clients (from invoice

[8] NMS considers its clients to be organizations or groups that contract with NMS to deliver products to public sector or private recipients. NMS charges these groups handling and storage fees that are negotiated in advance. Within the MOH, the NMS interacts with two major client groups that pay different pre-negotiated fees: MOH 1 (the larger group) and MOH 2 (primarily for handling STI drugs).

data) by the average volume per pack size group (measure C2). Each of the products was associated with one of four clients or users: MOH 1, MOH 2, Donor, or NMS Commercial Sales. The final step was to summarize the *Product volume per client* (measure C4) by adding the product volume associated with that client or user.

Measures C6 and C7

The study team then allocated the total operating costs for the NMS to each client using the two allocation statistics: percentage of total product value and percentage of total product volume. This calculation yielded two indicators: measure C6, *Operating cost per client, allocated by product value;* and measure C7**,** *Operating cost per client, allocated by product volume* (see table 7).

Table 7. Cost Recovery Analysis—Results

			Revenue from Handling Fees		Operating Costs if Allocated by…			% Prod. Value Needed
		Product Value	Total Paid in FY01	Rate in FY01	% Volume	% Value	% Cost Recovery	To Cover Op.
Customer	Volume	('000 UGX)	('000 UGX)	(% Vol)	('000 UGX)	('000 UGX)	(by vol.)	Costs (by vol.)
Measure:	C4	C5	C8		C7	C6	C9	C10
NMS	2,715	7,476,831	NA	NA	1,614,846	1,387,641	NA	21.60
MOH 1	236	2,541,787	254,179	10.0	140,370	471,736	181	5.52
Donor	2,495	7,241,402	724,140	10.0	1,483,993	1,343,948	49	20.49
MOH 2	3	202,962	13,192	6.5	1,784	37,668	739	0.88
Total	5,449	17,462,982	991,511	NA	3,240,993	3,240,993	NA	18.56

Finally, the study team examined revenue per client in relation to the allocated operating costs, comparing the two different allocation methods (see table 7). The current policy at NMS for charging clients is to calculate the handling fee as a percentage of product value. The study team showed that this method of calculating fees undercharges some clients while overcharging others (see measure C9, *Percentage cost recovery by volume*, in table 7).[9] The study also calculated the *required percentage of product value* that the NMS would need to charge each client in order for revenue to cover the client's fair share of operating costs allocated by volume (see measure C10). This analysis showed that donor fees would need to more than double, from 10 percent of product value now to 20.49 percent for full cost recovery. The study results are discussed further in section 5.

[9] Full cost recovery is 100%. A number under 100% means that revenue collected does not fully cover the costs of distribution, whereas a number higher than 100% means that the client is paying more than the full cost of distribution.

5. Using Cost Data and Findings

Capacity Analysis

The study showed that the NMS has limited capacity now to assume responsibility for delivery down to the HSD level. Maximum capacity, expressed in terms of vehicle operating days, would be exceeded if the change being considered were implemented. The study suggests that the Ugandan government and NMS consider two options. The first option is to add additional capacity by buying one more vehicle. This option obviously will incur new costs.

The second option is to improve the efficiency of the distribution process as it now operates. In other words, NMS can make changes to accomplish more deliveries using existing vehicle operating days or to complete the delivery tasks using less vehicle operating days.

The study team provided some suggestions for reducing loading time and unloading time. Loading time could be reduced by decreasing the number of hand-offs between porters, checkers, and drivers; using pallets for stacking cartons during the loading process; and shrink-wrapping pallets to reduce handling damage; and time needed to resolve damage problems. Unloading time could be reduced by working with districts to conduct root cause analysis, creating packing lists using bar code technology, staying to the delivery schedule, targeting certain check procedures to higher risk deliveries only, and using Service Delivery Promoter staff (NMS representatives in Districts) to perform some checks even after trucks have made their deliveries and departed.[10]

Cost Analysis

The study demonstrated that the incremental cost of adding HSD-level distribution to the responsibilities of the NMS would be two to 10 times higher than the probable costs now being incurred by the Districts and HSDs. Costs saved at the District level by shifting the responsibility for delivery will not be sufficient to cover the incremental cost, given the lower efficiency and higher cost structure of the NMS. In addition, operational problems with the release of local-level funds make this financing support problematic.

The study recommended that problem-solving strategies be used to improve the distribution process within existing structure. Some areas of focus may include how to improve the predictability of NMS delivery schedules; reduce waiting time and inefficiencies in current system; improve communications within District/HSD; ensure that auditors and vehicles are available when needed; and assign distribution tasks most efficiently among District, HSD, and facility-level staff.

Cost Recovery Analysis

The study showed that donors are not covering their fair share of operating costs with the current fee schedule, based on a percentage of product value. When costs are allocated on a volume basis (a more realistic driver of costs), then NMS is recovering only 49 percent of costs through revenue collected from donors. On the other hand, the MOH is paying more than a fair share of costs, contributing revenue equal to eight times their share of operating costs (allocated by volume). Therefore, the NMS commercial activities and the MOH are subsidizing the costs of distribution that are incurred by donors. The study recommends changes in the fee schedule to

[10] See appendix F (Abdallah, Healy, and O'Hearn 2002) for a fuller description of these ideas, as well as requirements for implementation.

increase the cost recovery from donors and improve the fairness of the system. The study also recommends changes to decrease total operating costs through efficiency improvements and cost reduction strategies.

6. Insights on Cost Analysis for Logistics

In addition to the information this study provided for Ugandan decision makers, the case study provides broader insights about conducting cost analysis for logistics systems. Some of these insights may be applicable to other country settings, and could help logistics managers choose methods of cost analysis and implement them effectively. Areas discussed include sampling, extrapolation, steps and methods of analysis, assumptions, and sensitivity analysis.

A. Sampling

While random sampling provides a more representative estimate, it can be costly and time-consuming and may not be advisable, depending on the study purpose and budget. With random sampling, each individual sampling unit has an equal chance of being included in the sample. This means that the estimates obtained are more representative of the larger population. A modification of random sampling, stratified random sampling, selects groups with differences that might affect the characteristic being assessed, so the findings are sure to account for these differences. For example, in this case, districts that were urbanized seemed likely to have different distribution costs than districts located in rural areas, while districts nearer to NMS might have lower distribution costs than districts located far from NMS.

The study team in Uganda did not elect to use random sampling. Most likely, the cost study would have cost more and taken longer if random sampling were used, because design and calculations are more complicated with this method. In this case, the study team chose instead to use a judgemental (purposive) sample designed to represent different characteristics of districts, without random selection.

Logistics managers may need to help clients to appreciate where random sampling may be worth the extra effort and cost, and where it would not. In this case, the possible benefits of random sampling in terms of additional accuracy of national estimates, were not outweighed by the additional costs and time delays that it would involve. Where judgemental sampling is used, it can be helpful to do what the Uganda study team did—involve client representatives in the selection of the sample to increase the likelihood that the sample will represent known differences thought to be important. This also helps ensure that the client will accept and use the results of the study after it is completed.

B. Extrapolation Methods

When extrapolating from sample data, weighting matters. Extrapolating is the process of inferring what the results or findings for a whole population would be (for example, the costs of nationwide distribution of medicines), based on results observed in a smaller sample (e.g., the costs of distribution in the eight districts in the study).

Extrapolation can be done by applying a sample-based rate to a general population.[11] For example, distribution costs for the eight sample districts were estimated to be 7.2 million UGX per year. This is about 1.4 UGX per person, using a weighted average, or 1.6 UGX per person using the non-weighted average. To estimate the costs for the nation, we multiply the sample-based cost per person by the number of people in the country (23.9 million). This gives us national estimates of around 34 million UGX weighted and 38 million UGX non-weighted. Table 8 displays that the study team also considered basing the extrapolation on sample distribution costs per HSD or per District. However, the population-based projection is preferred because the variability surrounding the population estimate is smaller compared to the HSD and district estimates, so the error around the unit cost is smaller.

Does weighting matter? Often, yes. It is usually safer to use weighted means for extrapolation as non-weighted means may not account for uneven distributions of population within the sampling units (districts). In the Uganda case study, the difference between the weighted and non-weighted estimates was about 13 percent. For the conclusions drawn from the study results, the ratio of NMS to district costs was the more important decision variable, so the difference in the extrapolations did not materially affect the conclusions drawn from the study.

Table 8. Comparison of Three Bases for Extrapolation of National Distribution Costs in Uganda

Extrapolation Base	Calculation	Result
Population	Sample cost per person, applied to the national population	38,967,405 UGX, non-weighted 34,055,382 UGX, weighted
Health Sub-District	Sample cost per HSD, applied to the total number of HSDs in Uganda	34,535,158 UGX, non-weighted 35,132,064 UGX, weighted
District	Sample cost per District, applied to the total number of Districts in Uganda	50,563,905 UGX, non-weighted 50,563,905 UGX, weighted

C. Steps and Methods of Analysis

A good cost study starts with a good understanding of the organization. To estimate costs accurately, you have to understand the system. What are the functions that the organization is carrying out? Who does what, and how and when is it done? Having a detailed understanding of operations helps the cost analysis team make reasonable assumptions. In Uganda, the study team spent time learning how the distribution system actually worked. This helped them recognize what was driving costs. For example, the team realized that the study needed to consider not only the cost of travel time but also the cost of lag time: the time spent waiting for auditors or other staff before a shipment could be unloaded. This was determined to be an important source of costs at the NMS level, but also was a factor that was amenable to programmatic interventions to reduce cost.

[11] Extrapolation can be done using an *inflator*. Inflators are developed by dividing total units by sample units. In this case, the total population is 23.9 million, and the population in the sample districts is 5.1 million, so the inflator is 23.9/5.1, or 4.7. The results of the study (7.2 million UGX in distribution costs) were multiplied by the inflator (4.7) to obtain a national estimate of distribution costs, 7.2 x 4.7 = 34 million UGX.

The perfect is the enemy of the good: it is better to base decisions on reasonable estimates than wait for perfect information. In this case, information on distribution costs at the district- and HSD-level was not being recorded, yet a central concern for the study was to compare these costs with NMS costs. Where financial records are not available or where there are doubts about the quality of data, a helpful strategy is to *triangulate* or measure the same characteristic through several methods to get a reasonable estimate. The study team followed this principle when they estimated district/HSD distribution costs in three ways (reported, estimated, and probable), as described in table 4. The study team also triangulated information by using both quantitative and qualitative data collection methods, including the survey of 150 managers.

Cost methods must match the decisions being made. Cost studies must start by getting a clear sense of the decisions that are being made: the selection of cost methods follows. In Uganda, the level of cost recovery achieved by NMS was a question that required full cost information. However, for other decisions, the study team needed to determine only incremental costs or how costs would be different if the system and structure for distribution were changed. Indirect costs were relevant for the full cost analysis but not for the incremental analysis.

This insight is also reflected in the study team's decision to extrapolate the sample data to the national level. The decision being made was about national policy and the structure of an organization with nationwide operations (i.e., adding delivery to the HSD level to the existing responsibilities of the NMS). Comparing the NMS-versus district-incurred costs just in the sample area would have demonstrated the ratio of NMS to district costs, but it would not have captured the resource implications of expanding NMS capacity to cover the whole country.

All costing is "local": costs must be defined and characterized for each study and situation. There are no universal definitions for what must be included in fixed, variable, direct, and indirect costs. These definitions depend on the management structure and operations of an organization as well as on the purpose for which the cost information is being collected. Local input is needed to determine how costs should be characterized for a cost study.

Once decided, the definitions must be applied consistently, and the study results must be viewed in the context. For example, the Uganda cost analysis did not consider vehicle standing costs such as depreciation or the cost of driver salaries at the district and HSD level. This decision was made because vehicles and drivers have other responsibilities besides the delivery of medicines, and depreciation and driver salaries would not be *saved* if delivery was conducted by the NMS rather than the districts. This assumption was appropriate for the decisions being considered. At the same time, the client should be aware that because driver salaries were not included in the cost analysis, it doesn't mean that the decision to restructure the distribution system will have no effect on driver's time allocation and productivity. It just means that, for this study, those effects were not analyzed and the costs were not relevant.

Cost studies can be threatening: gaining local trust is important. Cost information can prepare logistics managers to enter into negotiation, develop strategies, and advise other department managers or institutions. But, people can sometimes react negatively to a cost study because they see it as an attempt to highlight inefficiencies or corruption. The way one goes about asking people for information on costs is important. It must not be seen as an audit. In Uganda, local decision makers were made aware of why the information was needed and how it could be helpful. NMS and local staff were included in all phases of the research, and their insights helped frame the study assumptions and data collection. The qualitative interviews with key informants and the survey of 150 managers involved in the implementation of delivery systems were important opportunities used by the study team to allay suspicions and gain trust.

D. Assumptions and Sensitivity Analysis

A cost study with clearly stated assumptions has double the value. In every cost study, assumptions must be made. For example, in Uganda, the study team made assumptions about the number of operating days per year, average speed of vehicles, amount of time it takes to load and unload a truck, number of hours a person will work in a day, and price of fuel, among others. These assumptions were stated in many places in the study report. The value of a cost study is doubled when the assumptions are very clear because people may wish to challenge an assumption or apply the study results to another situation where different assumptions hold. Clearly stated assumptions make it easy to test what would happen if these assumptions are changed.

Sensitivity analysis helps determine which assumptions or factors have the most impact on study results. Where an assumption seems especially uncertain (such as the percentage of time that travel to deliver drugs is combined with other activities), or the actual situation seems far from the standard (such as the amount of time it takes to unload trucks in districts), it can be helpful to conduct a sensitivity analysis.

A sensitivity analysis recalculates the costs or capacity using alternative assumptions. Decision makers can then see whether their decision would change based on the new figures; in other words, is the decision *sensitive* to the change in the assumption.

In Uganda, a sensitivity analysis of the NMS delivery capacity under normal (current) conditions showed that an additional vehicle would be needed to deliver down to the HSD level. However, a sensitivity analysis showed that the vehicle might not be needed if reasonable improvements were made in decreasing the unloading time. In this case, sensitivity analysis showed that the time to unload vehicles is a factor that is critical to the decision being made.

A good cost study is not only accurate but accessible. Cost analysis is a difficult, detailed process, but, getting reasonably accurate results is only half the work. A good analysis must explain costs in a way that managers can understand. It must show managers how the results of the study can be used to make decisions to improve policies and program operations. The assessment of the costs of distribution in Uganda shows how important it is for logistics managers to be able to write about costs and communicate the meaning of cost information effectively. The secure supply of essential medicines throughout the country depends on it.

Reference

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